

What is claimed is:

1. An isolated protein, comprising an amino acid sequence selected from the group consisting of:
 - a. an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
 - 5 b. a homologue of said amino acid sequence of (a), wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61;wherein said protein has 10,12-linoleate isomerase enzymatic activity.
2. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under low stringency hybridization conditions to the complement of SEQ ID NO:60.
3. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under moderate stringency hybridization conditions to the complement of SEQ ID NO:60.
4. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under high stringency hybridization conditions to the complement of SEQ ID NO:60.
5. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence comprising at least 15 contiguous amino acids of SEQ ID NO:61.
6. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence comprising at least 30 contiguous amino acids of SEQ ID NO:61.
7. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence comprising at least 45 contiguous amino acids of SEQ ID NO:61.
8. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence comprising at least 24 contiguous nucleotides of SEQ ID NO:60.
9. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of SEQ ID NO:59 and SEQ ID NO:60.
10. The isolated protein of Claim 1, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence SEQ ID NO:60.

11. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61.

12. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence SEQ ID NO:61.

13. The isolated protein of Claim 1, wherein said protein is selected from the group consisting of *Propionibacterium acnes*, *Propionibacterium acidipropionici* and *Propionibacterium freudenreichii* linoleate isomerases.

14. The isolated protein of Claim 1, wherein said protein is a *Propionibacterium acnes* linoleate isomerase.

15. The isolated protein of Claim 1, wherein said linoleate isomerase converts linoleic acid and linolenic acid to (*trans*, *cis*)-10,12-linoleic acid.

16. The isolated protein of Claim 1, wherein said protein has a specific linoleic acid isomerization activity of at least about 10 nmoles CLA mg⁻¹ min⁻¹.

17. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence that aligns with SEQ ID NO:73 using Martinez/Needleman-Wunsch DNA alignment method with a minimum match of 9, a gap penalty of 1.10 and a gap length penalty of 0.33, wherein amino acid residues in said amino acid sequence align with at least about 70% of non-Xaa residues in SEQ ID NO:73.

18. The isolated protein of Claim 1, wherein said protein comprises an amino acid sequence that aligns with SEQ ID NO:73 using Martinez/Needleman-Wunsch DNA alignment method with a minimum match of 9, a gap penalty of 1.10 and a gap length penalty of 0.33, wherein amino acid residues in said amino acid sequence align with at least about 80% of non-Xaa residues in SEQ ID NO:73.

19. The isolated protein of Claim 1, wherein said protein is a soluble enzyme.

20. The isolated protein of Claim 1, wherein said protein comprises a leader sequence which causes insertion of said protein into the membrane of a cell which expresses said protein.

21. The isolated protein of Claim 1, wherein said protein is bound to a solid support.

22. The isolated protein of Claim 21, wherein said solid support is selected from the group consisting of organic supports, artificial membranes, biopolymer supports and inorganic supports.

23. The isolated protein of Claim 1, wherein said protein comprises at least one epitope that is bound by an antibody that specifically binds to a linoleate isomerase comprising an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61.

24. An isolated antibody that selectively binds to the isolated protein of Claim 1.

25. An isolated protein comprising an amino acid sequence selected from the group consisting of:

- a. an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
- 5 b. a homologue of said amino acid sequence of (a), wherein said homologue comprises an amino acid sequence that aligns with SEQ ID NO:73 using Martinez/Needleman-Wunsch DNA alignment method with a minimum match of 9, a gap penalty of 1.10 and a gap length penalty of 0.33, wherein amino acid residues in said amino acid sequence align with at least about
10 70% of non-Xaa residues in SEQ ID NO:73;

wherein said protein has 10,12-linoleate isomerase enzymatic activity.

26. The isolated protein of Claim 25, wherein said homologue comprises an amino acid sequence that aligns with SEQ ID NO:73 using said alignment program, wherein amino acid residues in said amino acid sequence align with at least about 90% of non-Xaa residues in SEQ ID NO:73.

27. A method for producing CLA (conjugated linoleic acid or conjugated linolenic acid) or derivatives thereof, comprising contacting an oil, said oil comprising a fatty acid selected from the group consisting of linoleic acid, linolenic acid, and a derivative of linoleic or linolenic acid, with an isolated protein having 10,12-linoleate isomerase enzymatic activity, to convert at least a portion of said fatty acid to CLA or a derivative thereof, said isolated protein comprising an amino acid sequence selected from the group consisting of:

- a. an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
- 10 b. a homologue of said amino acid sequence of (a), wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61.

28. The method of Claim 27, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under moderate stringency hybridization conditions to the complement of SEQ ID NO:60.

29. The method of Claim 27, wherein said protein comprises at least 15 contiguous amino acids identical to at least 15 contiguous amino acids of SEQ ID NO:61.

30. The method of Claim 27, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence comprising at least 24 contiguous nucleotides of SEQ ID NO:60.

31. The method of Claim 27, wherein said protein is encoded by a nucleic acid molecule comprising nucleic acid sequence SEQ ID NO:60.

32. The method of Claim 27, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61.

33. The method of Claim 27, wherein said protein comprises amino acid sequence SEQ ID NO:61.

34. The method of Claim 27, wherein said fatty acid is in the form of a triglyceride and wherein said method further comprises contacting said oil with a hydrolysis enzyme to convert at least a portion of said triglyceride to free fatty acids.

35. The method of Claim 34, wherein said hydrolysis enzyme is selected from the group consisting of lipases, phospholipases and esterases.

36. The method of Claim 27, further comprising the step of recovering said CLA or derivative thereof.

37. The method of Claim 27, wherein said oil is selected from the group consisting of sunflower oil, safflower oil, corn oil, linseed oil, palm oil, rapeseed oil, sardine oil, herring oil, mustard seed oil, peanut oil, sesame oil, perilla oil, cottonseed oil, soybean oil, dehydrated castor oil and walnut oil.

38. The method of Claim 27, wherein said linoleate isomerase enzyme is bound to a solid support.

39. The method of Claim 38, wherein said solid support is selected from the group consisting of organic supports, artificial membranes, biopolymer supports and inorganic supports.

40. An immobilized cell, wherein said cell is transfected with a recombinant nucleic acid molecule comprising a nucleic acid sequence encoding a protein having 10,12-linoleate isomerase enzymatic activity, wherein said protein comprises an amino acid sequence selected from the group consisting of:

- 5 a. an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
- b. a homologue of said amino acid sequence of (a), wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61;

10 wherein said nucleic acid sequence is operatively linked to a transcription control sequence.

41. The immobilized cell of Claim 40, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under moderate stringency hybridization conditions to the complement of SEQ ID NO:60.

42. The immobilized cell of Claim 40, wherein said protein comprises at least 15 contiguous amino acids of SEQ ID NO:61.

43. The immobilized cell of Claim 40, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence comprising at least 24 contiguous nucleotides of SEQ ID NO:60.

44. The immobilized cell of Claim 40, wherein said protein is encoded by a nucleic acid molecule comprising nucleic acid sequence SEQ ID NO:60.

45. The immobilized cell of Claim 40, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61.

46. The immobilized cell of Claim 40, wherein said protein comprises amino acid sequence SEQ ID NO:61.

47. The immobilized cell of Claim 40, wherein said recombinant nucleic acid molecule is integrated into the genome of said cell.

48. The immobilized cell of Claim 40, wherein said recombinant nucleic acid molecule is a plasmid.

49. The immobilized cell of Claim 40, wherein said recombinant nucleic acid molecule encoding said protein having linoleate isomerase enzymatic activity comprises a genetic modification which increases said linoleate isomerase enzymatic activity as compared to a naturally occurring linoleate isomerase comprising SEQ ID NO:61.

50. The immobilized cell of Claim 49, wherein said genetic modification reduces substrate inhibition of said protein having linoleate isomerase enzymatic activity as compared to a naturally occurring linoleate isomerase comprising SEQ ID NO:61.

51. The immobilized cell of Claim 49, wherein said genetic modification reduces product inhibition of said protein having linoleate isomerase enzymatic activity as compared to a naturally occurring linoleate isomerase comprising SEQ ID NO:61.

52. The immobilized cell of Claim 40, wherein said cell is selected from the group consisting of a bacterial cell, a fungal cell, a microalgal cell, an insect cell, a plant cell and a mammalian cell.

53. The immobilized cell of Claim 40, wherein said cell is a bacterial cell.

54. The immobilized cell of Claim 40, wherein said cell is a bacterial cell selected from the group consisting of *Propionibacterium*, *Escherichia* and *Bacillus* cells.

55. The immobilized cell of Claim 40, wherein said cell is a yeast cell.

56. The immobilized cell of Claim 40, wherein said cell has been lysed.

57. The immobilized cell of Claim 40, wherein said cell has been immobilized by crosslinking with a bifunctional or multifunctional crosslinking agent.

58. The immobilized cell of Claim 57, wherein said crosslinking agent is glutaraldehyde.

59. A method for producing CLA (conjugated linoleic acid or conjugated linolenic acid) or a derivative thereof, comprising contacting an oil, said oil comprising a fatty acid selected from the group consisting of linoleic acid, linolenic acid, and a derivative thereof, with an immobilized cell of Claim 36.

60. The method of Claim 59, wherein said fatty acid is in the form of a triglyceride and wherein said method further comprises contacting said oil with a hydrolysis enzyme to convert at least a portion of said triglycerides to free fatty acids.

61. The method of Claim 60, wherein said hydrolysis enzyme is selected from the group consisting of lipases, phospholipases and esterases.

62. The method of Claim 59, further comprising the step of recovering said CLA or derivative thereof.

63. The method of Claim 59, wherein said CLA is (*trans, cis*)-10,12-linoleic acid.

64. The method of Claim 59, wherein said oil is selected from the group consisting of sunflower oil, safflower oil, corn oil, linseed oil, palm oil, rapeseed oil, sardine oil, herring oil, mustard seed oil, peanut oil, sesame oil, perilla oil, cottonseed oil, soybean oil, dehydrated castor oil and walnut.

65. The method of Claim 59, wherein said step of producing said CLA from said oil provides at least about 50% conversion of said oil to said CLA or derivative thereof.

66. The method of Claim 59, wherein said cell is a bacterial cell.

67. The method of Claim 66, wherein said bacterial cell is *Escherichia coli*.

68. The method of Claim 66, wherein said bacterial cell is *Bacillus subtilis*.

69. The method of Claim 66, wherein said bacterial cell is *Bacillus licheniformis*.

70. An isolated nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of:

- a. a nucleic acid sequence encoding a protein having 10,12-linoleate isomerase enzymatic activity, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61;
- b. a nucleic acid sequence encoding a homologue of a protein of (a), wherein said homologue has 10,12-linoleate isomerase enzymatic activity, and wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61; and,
- c. a nucleic acid sequence that is fully complementary to any of said nucleic acid sequences of (a) or (b).

71. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises a nucleic acid sequence selected from the group consisting of:

- a. a nucleic acid sequence encoding a protein having 10,12-linoleate isomerase enzymatic activity, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
- b. a nucleic acid sequence encoding a homologue of a protein of (a), wherein said homologue has 10,12-linoleate isomerase enzymatic activity, and wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61.

72. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid sequence of (b) hybridizes under low stringency hybridization conditions to the complement of SEQ ID NO:60.

73. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid sequence of (b) hybridizes under moderate stringency hybridization conditions to the complement of SEQ ID NO:60.

74. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid sequence of (b) hybridizes under high stringency hybridization conditions to the complement of SEQ ID NO:60.

75. The isolated nucleic acid molecule of Claim 70, wherein said homologue comprises at least 15 contiguous amino acids of SEQ ID NO:61.

76. The isolated nucleic acid molecule of Claim 70, wherein said homologue comprises at least 30 contiguous amino acids of SEQ ID NO:61.

77. The isolated nucleic acid molecule of Claim 70, wherein said homologue comprises at least 45 contiguous amino acids of SEQ ID NO:61.

78. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid sequence of (b) comprises at least 24 contiguous nucleotides of SEQ ID NO:60.

79. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises a nucleic acid sequence selected from the group consisting of SEQ ID NO:59 and SEQ ID NO:60.

80. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises nucleic acid sequence SEQ ID NO:60.

81. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises a nucleic acid sequence encoding an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61.

82. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises a nucleic acid sequence encoding amino acid sequence SEQ ID NO:61.

83. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule is selected from the group consisting of *Propionibacterium acnes*, *Propionibacterium acidipropionici* and *Propionibacterium freudenreichii* linoleate isomerase nucleic acid molecules.

84. The isolated nucleic acid molecule of Claim 70, wherein said nucleic acid molecule comprises a *Propionibacterium acnes* nucleic acid molecule.

85. A recombinant nucleic acid molecule comprising an isolated nucleic acid molecule as set forth in Claim 71 operatively linked to a transcription control sequence.

86. A recombinant virus comprising an isolated nucleic acid molecule as set forth in Claim 71.

87. A recombinant cell comprising an isolated nucleic acid molecule as set forth in Claim 71, wherein said cell expresses said nucleic acid molecule.

88. The recombinant cell of Claim 87, wherein said cell is selected from the group consisting of bacterial, fungal, microalgal, insect, plant and mammalian cells.

89. The recombinant cell of Claim 87, wherein said cell is immobilized on a substrate.

90. The recombinant cell of Claim 87, wherein said cell is a microorganism selected from the group consisting of *Propionibacterium acnes*, *Propionibacterium freudenreichii*, *Propionibacterium acidipropionici*, *Escherichia coli*, *Bacillus subtilis*, and *Bacillus licheniformis*.

91. The recombinant cell of Claim 87, wherein said cell is a microorganism selected from the group consisting of *Escherichia coli*, *Bacillus subtilis* and *Bacillus licheniformis*.

92. A method for producing CLA (conjugated linoleic acid or conjugated linolenic acid) or a derivative thereof, comprising contacting an oil, said oil comprising a fatty acid selected from the group consisting of linoleic acid, linolenic acid, and a derivative thereof, with an isolated linoleate isomerase enzyme encoded by the isolated nucleic acid molecule of Claim 71 to convert at least a portion of said fatty acid to CLA or a derivative thereof.

93. The method of Claim 92, wherein at least about 30% of said fatty acid is converted to CLA or a derivative thereof.

94. The method of Claim 92, wherein at least about 50% of said fatty acid is converted to CLA or a derivative thereof.

95. The method of Claim 92, wherein at least about 70% of said fatty acid is converted to CLA or a derivative thereof.

96. A method to produce linoleate isomerase, comprising culturing a recombinant cell under conditions whereby said linoleate isomerase is produced, wherein said recombinant cell is transfected with an isolated nucleic acid molecule comprising a nucleic acid sequence selected from the group consisting of:

- 5 a. a nucleic acid sequence encoding a protein having 10,12-linoleate isomerase enzymatic activity, wherein said protein comprises an amino acid sequence selected from the group consisting of SEQ ID NO:42 and SEQ ID NO:61; and,
- 10 b. a nucleic acid sequence encoding a homologue of a protein of (a), wherein said homologue has 10,12-linoleate isomerase enzymatic activity, and wherein said homologue is at least about 35% identical to SEQ ID NO:61 over at least about 170 contiguous amino acids of SEQ ID NO:61.

97. The method of Claim 96, wherein said recombinant cell is from a microorganism selected from the group consisting of *Propionibacterium acnes*, *Propionibacterium freudenreichii*, *Propionibacterium acidipropionici*, *Escherichia coli*, *Bacillus subtilis* and *Bacillus licheniformis*.

98. The method of Claim 96, wherein said recombinant cell is from a microorganism selected from the group consisting of *Escherichia coli*, *Bacillus subtilis* and *Bacillus licheniformis*.

99. An isolated protein comprising an amino acid sequence selected from the group consisting of:

- a. SEQ ID NO:64; and,
- b. a homologue of SEQ ID NO:64, wherein said homologue is at least about 35% identical to SEQ ID NO:64.

100. The isolated protein of Claim 99, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under moderate stringency conditions to the complement of SEQ ID NO:63.

101. The isolated protein of Claim 99, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under high stringency conditions to the complement of SEQ ID NO:63.

102. The isolated protein of Claim 99, wherein said protein is encoded by a nucleic acid sequence comprising at least 24 contiguous nucleotides of SEQ ID NO:63.

103. The isolated protein of Claim 99, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence represented by SEQ ID NO:63.

104. The isolated protein of Claim 99, wherein said protein comprises amino acid sequence SEQ ID NO:64.

105. The isolated protein of Claim 99, wherein said protein comprises an amino acid sequence having an esterase/lipase/thioesterase active site denoted by ProfileScan Profile No. PS50187.

106. The isolated protein of Claim 99, wherein said protein comprises an amino acid sequence having a carboxylesterase type-B active site denoted by ProfileScan Profile No. GC0265.

107. The isolated protein of Claim 99, wherein said protein has lipase enzymatic activity.

108. An isolated nucleic acid molecule comprising a nucleic acid sequence encoding a protein comprising an amino acid sequence selected from the group consisting of:

- a. SEQ ID NO:64; and,
- 5 b. a homologue of SEQ ID NO:64, wherein said homologue is at least about 35% identical to SEQ ID NO:64.

109. An isolated protein comprising an amino acid sequence selected from the group consisting of:

- a. SEQ ID NO:69; and,
- b. a homologue of SEQ ID NO:69, wherein said homologue is at least about 40% identical to SEQ ID NO:69 over at least about 60 contiguous amino acid residues of SEQ ID NO:69.

110. The isolated protein of Claim 109, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under moderate stringency conditions to the complement of SEQ ID NO:68.

111. The isolated protein of Claim 109, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence that hybridizes under high stringency conditions to the complement of SEQ ID NO:68.

112. The isolated protein of Claim 109, wherein said protein is encoded by a nucleic acid molecule comprising a nucleic acid sequence represented by SEQ ID NO:68.

113. The isolated protein of Claim 109, wherein said protein comprises amino acid sequence SEQ ID NO:69.

114. The isolated protein of Claim 109, wherein said protein comprises an amino acid sequence having an acetyltransferase (GNAT) family profile denoted by ProScan Profile No. PF00583.

115. The isolated protein of Claim 109, wherein said protein has acetyltransferase enzymatic activity.

116. An isolated nucleic acid molecule comprising a nucleic acid sequence encoding a protein comprising an amino acid sequence selected from the group consisting of:

- a. SEQ ID NO:69; and,
- 5 b. a homologue of SEQ ID NO:69, wherein said homologue is at least about 40% identical to SEQ ID NO:69 over at least about 60 contiguous amino acid residues of SEQ ID NO:69.